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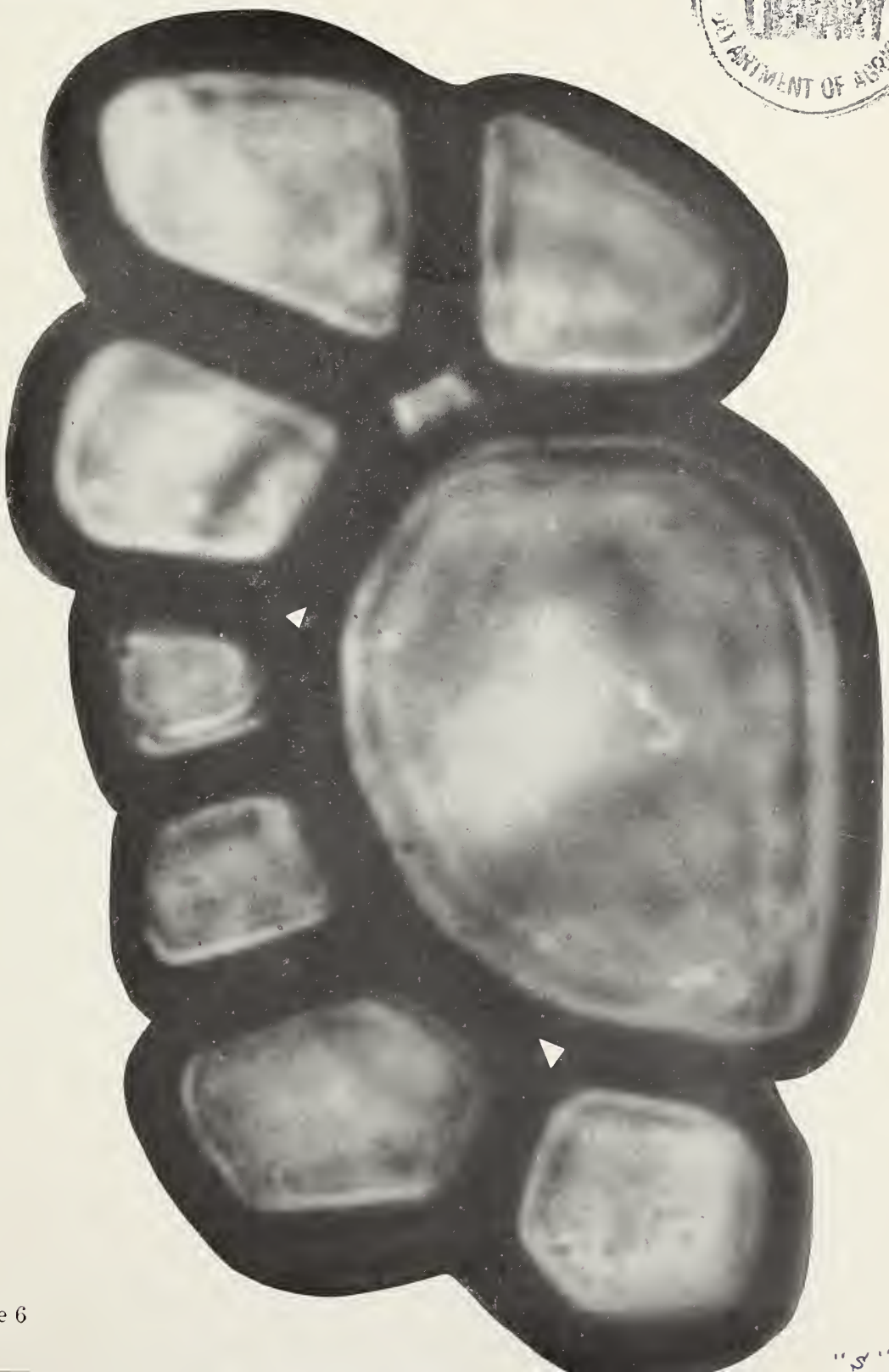

Phloem Fiber:
A Dual Role Page 6

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Ponder the Bat

Scientists are reaching into nature's biological and genetic supply bins for some unusual tools to ease major hazards of man. Three of these tools—for use against air pollutants, drought, and insect pests—are discussed in this issue.

- A biological trait of pine trees makes it possible for scientists to tell when air is polluted—even what it is polluted with (page 16).
- New knowledge about creeping-rooted alfalfa—with built-in drought resistance—brightens prospects for a forage crop adapted to semi-arid areas (page 11).
- Sounds made by bats while pursuing insects have been simulated and look promising as a means of driving certain insect pests from fields of cotton, corn, and tomatoes (page 5).

Air pollutants are costing today's producers millions of dollars a year in losses of crops, livestock, and trees. As our society becomes more urbanized and mechanized, these pollutants will multiply.

Pine trees will not alleviate this problem, of course, but seedlings that respond only to a single pollutant—and resist others—would be valuable as biological indicators that signal the presence of a given pollutant.

Creeping-rooted alfalfa—although still experimental—could have widespread benefit in semi-arid areas where legume stands cannot be established by seeding. Besides providing grazing for cattle and sheep, it would serve also as a protective cover against wind erosion.

But the application of nature's tools perhaps is better illustrated through man's use of sound—specifically, the cries of a curious creature, the bat.

Observing its habit of feeding at night, and the radar-like sounds it employs to locate insects, entomologists pondered the effect that simulated bat sounds would have in frightening pests away from field crops. Their observations may well pay off—just as did the observations of those who pioneered radar. They also pondered the bat.

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Orville L. Freeman, Secretary,
U.S. Department of Agriculture

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Agricultural Research Service

Eliminating Afterfoam

Detergents made from fats break down readily in streams, soil, and sewage plants

■ If we were using fat-based detergents in our laundries, kitchens, and bathrooms, we would be rid of a lot of the foam that blankets some of our rivers and streams and in some places puts a head on a glass of water drawn from the tap.

A series of tests by ARS chemists at the Eastern utilization research laboratory, Philadelphia, shows that detergents made from fats are biodegradable. That is, they are readily broken down by the micro-organisms in streams, in the soil, and in sewage-treatment systems.

Fat-based detergents proved much more biodegradable than alkylbenzene-sulfonates (ABS), today's most widely used detergents. They were even more biodegradable than those ABS compounds that have been chemically modified to make them more susceptible to microbiological attack.

When ABS was first identified as the foaming agent, Dr. Alexander J. Stirton and other members of the detergent investigations group at the Philadelphia laboratory expanded their study of detergents they had developed over the past 10 years from inedible animal fats.

Making detergents from fats was one of the first projects investigated by ARS when the traditional market for fats in soap was threatened by detergents made principally from petroleum.

Some excellent fat-based detergents have come from this research. Because of their limited commercial development, however, the fat-based types have not been priced competi-

Foam builds up on a stream into which detergent-containing wastes have been diverted.

Chemist T. C. Cordon adjusts the flow of sludge into a digester which tests the ability of bacteria to break down different types of detergents.

Afterfoam (*Continued*)

tively with other detergents.

The detergents developed in Philadelphia consist mainly of two chemical types, alcohol sulfates, which are better detergents than ABS, and sulfonated fatty acid esters, which are at least as good as ABS.

The ARS chemists believed that the chemical structure of their detergents should make them inherently biodegradable. If this could be established, they reasoned, a demand for them could develop and the large-scale production would bring down their cost.

They undertook an evaluation of the biodegradability of the fat detergents in comparison with the two types of ABS. Detergent manufacturers developed the more biodegradable ABS by replacing its conventional branched-chain chemical structure, which is difficult for micro-organisms to assimilate, with a straight-chain structure.

The detergents were investigated under both aerobic and anaerobic conditions (in the presence or absence of oxygen) because waste materials must be digested by micro-organisms whether oxygen is present or not. The tests were by microbiologist T. C. Cordon and chemist E. W. Maurer.

Under aerobic conditions, the detergents were subjected to a test that simulates the treatment of sewage in a municipal plant. Activated sludge, obtained from a nearby plant, was processed in small laboratory aerators to eliminate any detergent that may have already been present in the sludge. Then, as aeration continued, measured amounts of detergent were added. The effluent was analyzed daily to determine how efficiently the detergents were digested by the sludge micro-organisms.

In this test, six different fat-based detergents (three sulfates and three esters) proved distinctly more biodegradable than straight-chain ABS compounds—and far more so than the branched-chain type. Rarely were more than 1 or 2 parts per million of these fat-based detergents detected in the effluents during more than a month of laboratory aeration. Detection of the ABS detergents averaged 3½ to 11 p.p.m., ranging up to 17 p.p.m.

In another test the detergents were added to river water, which was analyzed daily to see how long traces could be found. Eighty percent of the fat-based detergents had disappeared in 1 to 3½ days for the alcohol sulfates, 4 to 5 days for the esters.

It took over a month for 80 percent of the branched-chain ABS compound to disappear and 3½ to 5 days for those with the straight chain.

Perhaps even more significant was the series of experiments carried out in the absence of air. Wastes discharged into septic tanks, drain fields and cesspools are often deprived o air. If detergents cannot be digeste microbially under these condition they may find their way into wells o other sources of pure water.

The ARS scientists demonstrate that fat-based detergents of the alc hol-sulfate type are readily degrade when no air is present. The AB compounds, whether of the straigh chain or branched-chain variety, n only failed to be digested but actuall appeared to have a toxic effect upo the micro-organisms.

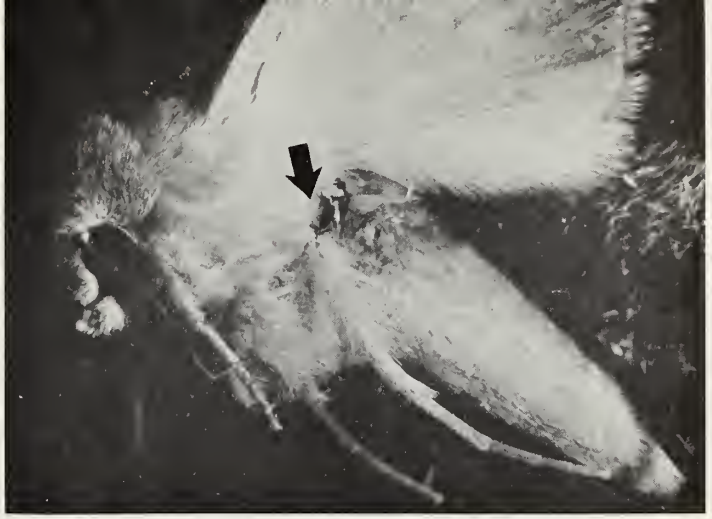
In these tests, sludge and raw sew age that had been aerated were pu into a closed container in an incu bator. A tube carried the gas pr duced by the digesting sludge outsid the incubator where it was collecte and measured in a polyethylene cyli der inverted in water. Each day th sludge was analyzed for detergen and fresh sludge and more detergen were added.

Over a period of a month, pract cally no traces of alcohol sulfates wer found in the sludge, indicating con plete microbial digestion. ABS d tergents, in contrast, accumulated i proportion to the amounts added.

Even more serious—gas productio from sludge containing the ABS d tergents dropped sharply after abou 10 days and soon stopped altogethe

The fat-based detergents—even th esters, which were not degrade under these anaerobic conditions— had no such adverse effects on ga production.

The researchers recognize that th concentration of detergents in satu rated soil or in anaerobic digesters i sewage-treatment plants normally ma not reach the levels shown in the test to be toxic to micro-organisms. Stil they point to the need of detergent like those made from fats which wi not destroy the very micro-organism that should be depended upon t digest them.☆



Bat-like sounds are picked up through hearing organs, called tympanums (see arrow), that are comparable to the human eardrum.

An Electronic Scarecrow

Entomologists test simulated bat sounds to frighten insects away

High-pitched sounds similar to those made by bats while hunting night-flying insects may become a weapon against the bollworm, a destructive pest of cotton. The insect (*Heliothis zea*), which attacks many crops, is also known as the corn earworm and the tomato fruitworm.

Bats, which feed on night-flying insects, emit high-frequency sounds that function like radar and allow them to locate their prey. But the bollworm moth and other moths pick up these sounds through hearing organs (tympanums) comparable to the eardrum and are warned of the bat's approach. They then begin spiraling, diving, and other evasive actions to escape the bat.

ARS entomologists H. R. Agee and H. M. Taft, in cooperative research with the South Carolina Agricultural Experiment Station, are using electronic equipment to simulate the bat sounds.

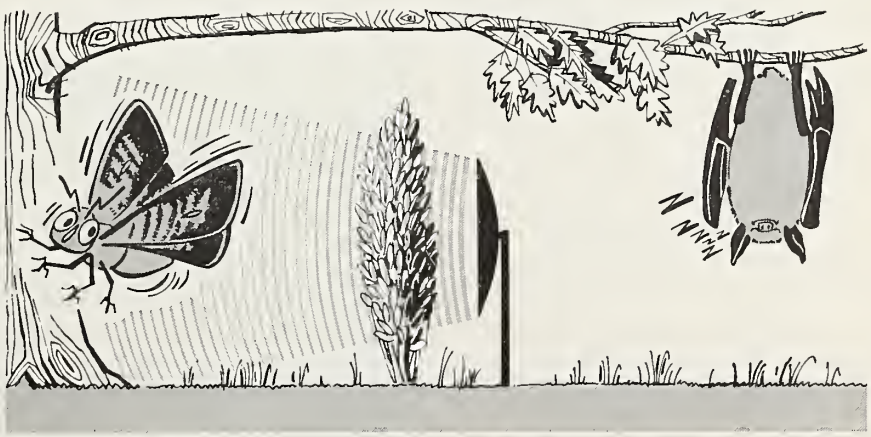
The high-frequency sound is intended to drive away bollworm moths infesting a cotton field as well as to prevent others from invading the area and laying eggs. If the technique proves successful, there would be less need to depend on insecticides for protecting cotton against the bollworm, which ranks second only to the boll weevil in its destructiveness. In some years it has been the No. 1 cotton pest in the United States.

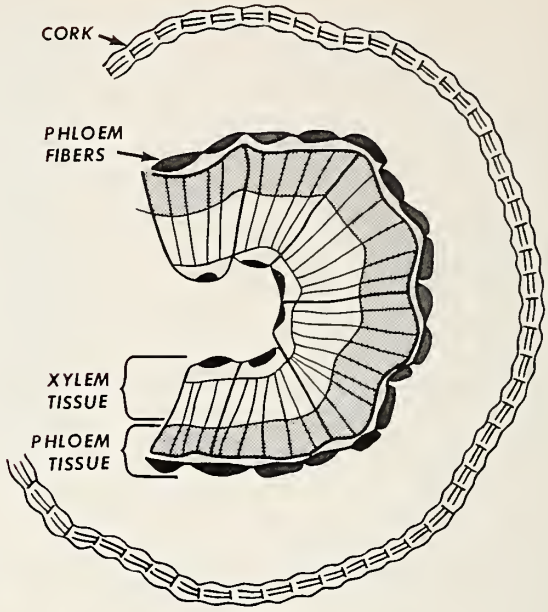
In laboratory tests, the moths' response to the simulated sounds was similar to the reaction of moths to actual bat sounds. Evaluation of data from field tests conducted during the 1964 growing season has not yet been completed. In the field tests, a rotating loud speaker sent sound waves over entire fields.

Agee and Taft tried varying sound frequencies in the laboratory and measured the moth's physical response, detected as electrical impulses. They ran electrodes from the moth's tympanic nerve fiber to equipment that amplified the electrical impulses and transmitted them to an oscilloscope screen to observe the reactions.

These tests indicated that bursts of sound at a frequency of 21 kilocycles per second may be the most effective for field use. This frequency would not affect any beneficial insects, they believe, and would not disturb humans. The human ear usually can detect sounds up to only a frequency of about 15 to 18 kilocycles per second.

Although the electronic technique looks promising, Agee and Taft say much more study and testing will be required to determine its effectiveness in controlling insects. They believe it would be economically feasible where there is a sizable bollworm infestation.☆





Phloem Fiber: A Dual Role

Besides supporting stems, phloem fibers may transport nutrients, other substances

■ Fibers in plant phloem tissue may play a double role. They may serve as continuous pathways for the movement of plant nutrients and other substances, as well as their known function of providing mechanical support to plant stems.

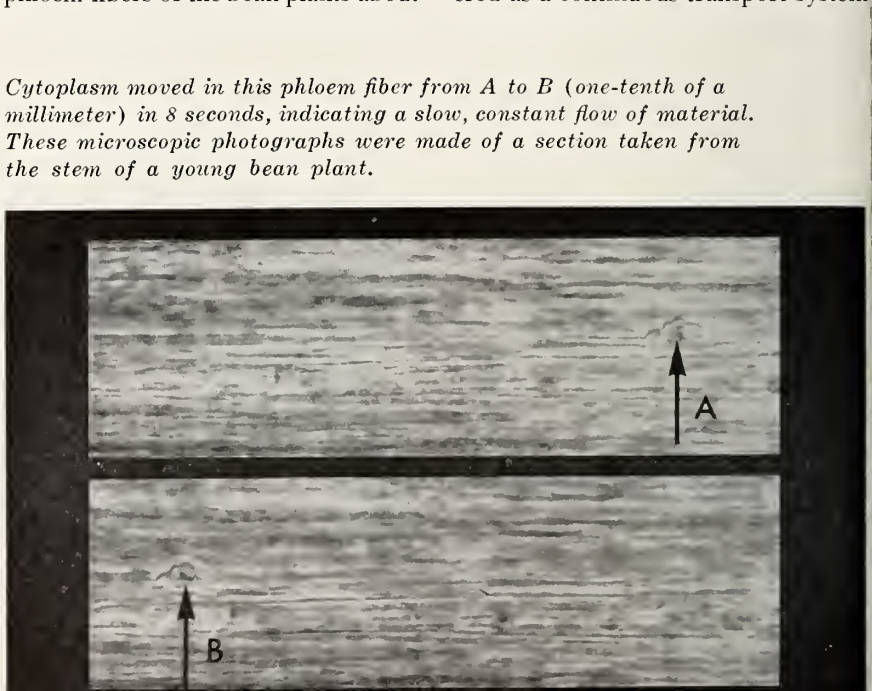
In research at Beltsville, Md., plant physiologist J. W. Mitchell and plant pathologist J. F. Worley observed minute particles being transported by the continuous rotational flow of cytoplasm within the phloem fibers of young bean plants. This is the first time that cytoplasm, a clear liquid found in living plant cells, has been reported flowing in a rotational course in plant fibers.

The scientists now are trying to find out whether the phloem fibers also channel materials from cell to cell or fiber to fiber.

Mitchell and Worley believe that phloem fibers have three characteristics which might account for the channeling of materials in this way: The length of the fiber, the continuous rotational movement of cytoplasm from one end of the long fiber to the other, and the many pits (approximately 3 million per inch of stem) in the walls of these fibers. In the Beltsville studies, cytoplasm moved in the phloem fibers of the bean plants about 25 times as far as material travels in an ordinary cell.

Scientists generally agree that substances move through pits in the walls of phloem fibers, in order to maintain the living material in each fiber. But phloem fibers have not been considered as a continuous transport system

Cytoplasm moved in this phloem fiber from A to B (one-tenth of a millimeter) in 8 seconds, indicating a slow, constant flow of material. These microscopic photographs were made of a section taken from the stem of a young bean plant.



ABOUT THE COVER—Phloem fibers are usually arranged in closely packed columns in a plant stem. Rotational streaming of cytoplasm was observed in fibers similar to the microscopic cross-sectional view (left). The diagram, also in cross section, shows location of phloem tissue, phloem fibers, and xylem tissue. Cork forms the outer wall of the stem.

through a plant. The transport systems in plants have been known to include xylem cells that function mainly as water and mineral carriers and phloem sieve tubes that carry various organic substances.

Should the ARS scientists establish conclusively that phloem fibers channel not only plant foods but also growth-regulating chemicals and other organic substances through plants, this finding would contribute significantly to an understanding of the upward and downward movement of materials in plants. Phloem fiber transport may be significant, for example, in the translocation of chemicals that kill weeds or protect crop plants.

Phloem fibers, which usually are arranged in closely packed columns, are part of the complex phloem tissue in plants. (See drawing.) Scientists have thought until now that these and other plant fibers serve only one function, that of holding up plant stems.

Mitchell and Worley noted the relatively slow but constant movement of cytoplasm in phloem fibers very early in the life of the bean plants, before the plants emerged above the surface of the soil. As plants mature, the walls of the fiber grow thicker, and eventually may fill almost the entire fiber.☆

Instant Applesauce...

Byproduct of explosion puffing has texture of sauce from fresh apples

■ ARS engineers who developed explosion puffing as a means of making quick-cooking dehydrated foods have now come up with instant applesauce—a promising byproduct of their research.

When dehydrated apple pieces made by the explosion-puffing process are coarsely ground and sweetened, a free-flowing granular material results that can be converted instantly to applesauce by adding hot water. The sauce not only has good flavor, it also has the desirable "grain" of that made from fresh apples.

If protected from moisture pickup, instant applesauce will keep for a long time under kitchen conditions. And its weight is only about a fifth that of canned applesauce, so it's cheaper to ship and it takes less room on the shelf.

Apple pieces were one of the first products to be dehydrated by the explosion puffing method at the Eastern utilization research laboratory, Philadelphia (AGR. RES., April 1964, p. 3). The process has also been adapted to blueberries, potatoes, carrots, beets, turnips, and sweetpotatoes.

The foods are dehydrated conventionally to remove most of the moisture. Then they are heated rapidly in a rotating pressure vessel and released suddenly to atmospheric pressure. This explosive release gives the pieces a porous structure, which permits the rest of the moisture to be removed much more rapidly—and at less expense. The dehydrated pieces can be cooked in a fifth to a tenth of the time usually required for dehydrated fruits and vegetables.

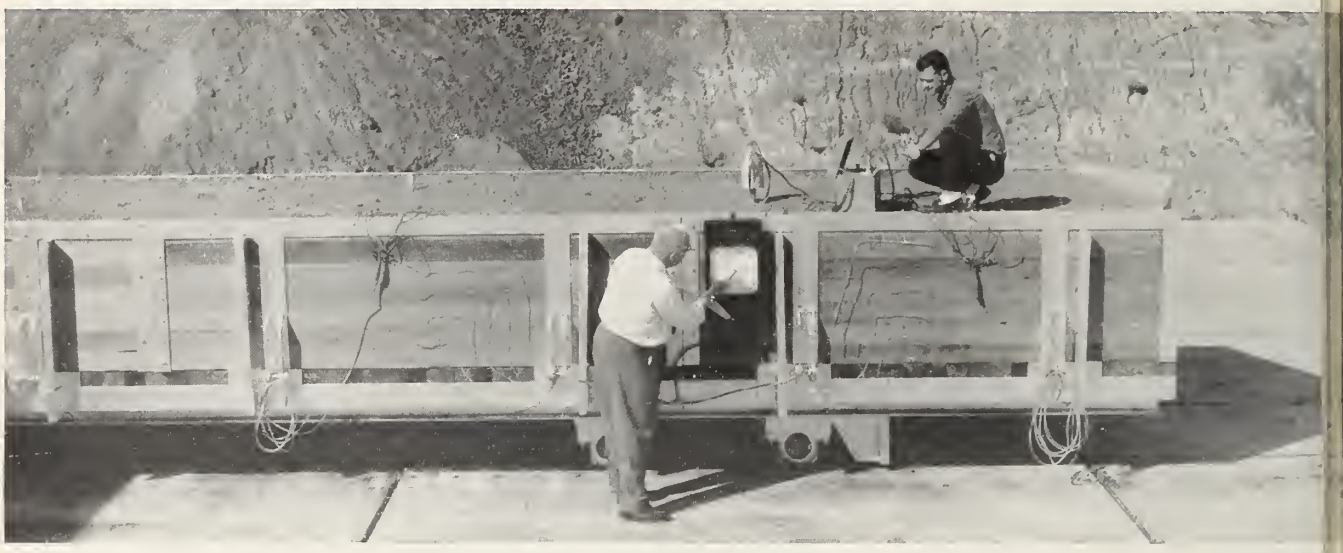
Dried to about 2-percent moisture in this manner, apple pieces are crisp and can readily be crushed to any degree of fineness. To make instant applesauce, the pieces are granulated, passed through a 20-mesh screen, and sweetened. The amount of sugar added is determined by the variety of apple. York Imperials were used in the tests; other varieties may also be adaptable.

Instant applesauce can be made to any degree of graininess or smoothness by varying the fineness to which the puffed pieces are crushed.

Although the new product is not yet on the market, potential producers of the sauce, food processors, and institutional users may obtain information on the process and samples of the product by writing to the Eastern Utilization Research and Development Division, Philadelphia, Pa., 19118.☆

New soils laboratory houses research to solve erosion problems in a . . .

MAN-MADE



Scientists at a unique new ARS soil and water laboratory at Pullman, Wash., can create desired soil and climatic conditions—any time of the year—in studying management practices to reduce severe soil erosion in the Palouse area of the Pacific Northwest.

Intensive research is needed because present practices in the Pacific Northwest are only partly successful in the Palouse—and because methods that accurately predict soil loss east of the Rockies are not adapted to the Far Western area.

Steep and long slopes . . . winter rains . . . rapidly melting snow held high on the slopes . . . and unprotected soil that is alternately frozen, partly frozen, or unfrozen . . . all these contribute to the erosion hazard in a 9-million-acre area in Washington, Idaho, and Oregon, where winter wheat and peas are the principal crops.

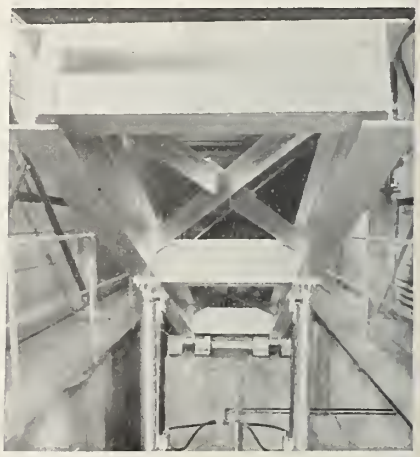
Two-thirds of the annual precipitation (10 to 25 inches) occurs in October through March, when the soil is bare, or before fall-seeded wheat has developed sufficiently to become an erosion-resisting cover.

The Palouse terrain is characterized by slopes that differ materially in microclimate. Long southwest slopes, facing the prevailing winds, receive the greater part of the snow; shaded northeast slopes are short and steep—up to 50 percent grade—and lose as much as a third less moisture by evaporation.

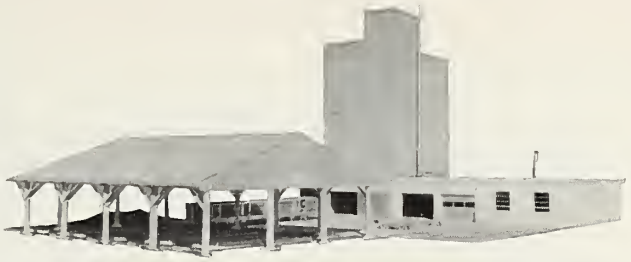
ARS agricultural engineer, S. J. Mech, who directs the new facilities as part of the Palouse Conservation Field Station at Pullman, estimates that the northeast slopes produce up to two-thirds of the winter erosion. The conditions causing this erosion will be investigated in detail by ARS soil scientists and agricultural engineers, in cooperation with the Washington Agricultural Experiment Stations.

The laboratory, unlike any other in existence, has facilities for duplicating under controlled conditions most of the influences contributing to runoff and soil loss in the Palouse. No longer must the scientists wait

A hydraulic lift in the raintower raises one end of the plot to provide desired slope in erosion studies.



CLIMATE



LEFT—Eight-by-40-foot soil cars are mounted on tracks and can be rolled to any indoor or outdoor work area. Here researchers check over instruments on one of the cars prior to a study.

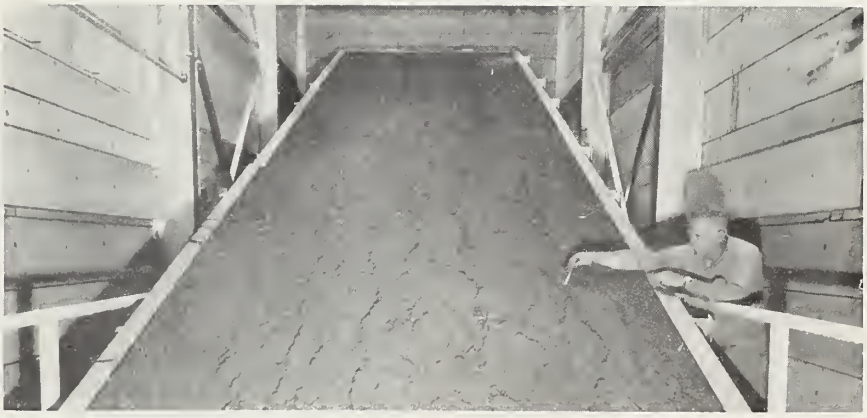
RIGHT—Soil car—with hood in place— is ready for freezing to duplicate winter conditions. Refrigeration units are seen.

until winter and then hope that the right set of erosive conditions develops.

They can reproduce the steep slopes by elevating one end of their soil plots. They can simulate rainfall—anything from a light mist to a cloudburst—and control the temperature of the water and air. They can freeze the soil, from the top down as occurs in nature, and then thaw the frozen soil. They can simulate wind, either gusty or without turbulence, and they can till the soil plots or establish various crop-cover conditions.

Unlike most laboratory studies, which employ small containers or plots of soil, much of the research at the Palouse laboratory will be done on plots 40 feet long and 8 feet wide, a size approaching that of plots used in field experiments.

The 50 tons of soil making up each plot are contained in a specially built car that rolls on standard-gage tracks.



Scientist measures the erosive effects of simulated winter rain or frozen soil, the surface of which had been permitted to thaw.

These movable plots can be prepared and instrumented in indoor or outdoor work areas and rolled into a raintower for experiments.

The raintower is a structure 15 feet wide, 50 feet long, and 50 feet high. Its height permits raindrops, falling from the top of the tower, to attain terminal (maximum) velocity—at which their erosive force is greatest—before striking the soil. The raintower contains all equipment for simulating natural conditions other than the soil freezing and thawing facilities, which are in the indoor work area of the new laboratory.☆

For Potatoes...

A WHEAT STUBBLE SEEDBED

■ The neighbors were skeptical when they saw researchers planting potatoes in wheat stubble. Although they recognized immediately that eliminating seedbed preparation would materially reduce production costs, they wondered if it was practical.

It was. ARS agricultural engineer G. W. French and University of Minnesota soil scientist G. R. Blake found that potato yields and quality were about equal in 3-year tests on untilled and conventionally plowed plots.

Plowed plots yielded less than the no-tillage treatment in all but 1 year, when yields on fall-plowed and untilled plots were equal in a season with high May rainfall.

Compared five tillage treatments

French and Blake compared five tillage treatments: No tillage (potatoes planted in undisturbed wheat stubble), fall plowing, spring plowing, fall deep tillage, and spring deep tillage.

Their experiments, conducted at the Red River Valley Potato Growers Research Farm near Grand Forks, N. Dak., were on plots that had been in spring wheat the previous season.

Spring and fall plowing was to a depth of 6 inches, and spring plowing and spring deep tillage were completed 1 to 4 days before planting. Points of the deep chisel plow were spaced 11 inches apart and penetrated the soil 8 to 10 inches.

French reported no difficulty planting directly in stubble in 1961 and 1962. But in 1963 the amount of straw was much greater, and it frequently clogged the furrow-opener disks on the planter and interfered with the first cultivation. The straw did not hinder subsequent cultivations, however.

The no-tillage treatment delayed those plants that normally would have emerged first, French found, but the overall emergence of the crop was not affected.

Cultivation completely controlled weeds on all plots.

Early weed growth was much greater on the unplowed plots, although there was no apparent difference between plots after the second cultivation. The furrow openers and covering disks of the planter removed the weeds in the rows; cultivation eliminated weeds between rows.

The type of tillage did not markedly affect the operation of the potato digger. But both deep tillage and plowing, when done in the spring, seemed to result in more clods, which may be picked up with the potatoes at harvest time.☆

TOP—Potatoes were planted directly in wheat stubble—of this density—and the results were compared with four other treatments, including deep tillage. Bottom—overall emergence of the crop was not affected by the different tillage treatments, as can be seen by the uniformity of the five plots, front to back. All plots were cultivated to control weeds.

Creeping-rooted alfalfa sends out lateral roots, along which stem buds develop at irregular spacings. Two of the buds are seen on this root.

Scientists learn more about...

Alfalfa that Creeps

■ ARS and Pennsylvania scientists have found that the spreading habit of creeping-rooted alfalfa is affected by daylength and the amount of top growth of the plant.

Their findings may be a help to plant breeders attempting to develop the potential of creeping-rooted alfalfa as an important forage crop in specific areas, including those affected by drought.

Alfalfa that has this creeping-rooted habit sends out lateral roots, along which stem buds develop at irregular spacings. New shoots then rise from these buds and become separate plants.

Once established under ideal conditions, a creeping-rooted alfalfa plant and its offshoots may spread several feet annually.

Creeping-rooted alfalfa, not intended as a replacement for common alfalfa, is drought resistant and is adapted to areas where common alfalfa is subject to heaving caused by alternate freezing and thawing. It shows promise also in areas where alfalfa is used for grazing.

Five alfalfa plants developed along the lateral root system extending out from the larger "parent" plant. The new shoots develop and eventually will be able to survive as separate plants.

Established best in the fall

In field-plot tests conducted under natural growing conditions, creeping-rooted alfalfa plants that became established in the fall produced more stems on their roots than those established in late spring.

Short daylengths resulted in reduced top growth, and the shorter the plant's top growth, the more stems there were on the roots. The scientists believe that the rapidly growing tops of plants in some way inhibited stem production on the roots.

The test results indicate that daylength should be considered in developing creeping-rooted alfalfa varieties adapted to different parts of the country, since the creeping habit may differ from one region to another.

G. E. Carlson and V. G. Sprague, ARS research agronomists, and J. B. Washko, professor of agronomy at the Pennsylvania Agricultural Experiment Station, conducted the tests at University Park, Pa.

The scientists are continuing their studies to improve this plant's vigor and yield and to gain a better understanding of the complex environmental and genetic relationships that affect the spread of creeping-rooted alfalfa. The plant now is slow growing and relatively low yielding, varying greatly in density of spread.☆

What about...

Resistant Sugarbeets?

Experimental lines show excellent defense against cyst nematode and root rot

Crop scientists who begin research with one objective in mind often go beyond the intended goal, as was the case in sugarbeet studies at Salinas, Calif.

Eight years ago ARS agronomist Charles Price joined in research already in progress to find sugarbeets that resist the cyst nematode. He now has experimental lines that are resistant to a combination of cyst nematodes *and* root-rotting fungi.

How did this happen? To expose plants to cyst nematodes, Price grew them in soil that was naturally infested with the pests. Although he knew that the soil was also heavily infested with fungus organisms (predominantly *Rhizoctonia*) that cause root rot, he did not anticipate that his screening and testing would uncover an interrelated resistance. On discovering this, he immediately changed his objective to a dual one.

Although much work remains to be done, Price says that 10 experimental sugarbeet lines have significantly outyielded commercial check varieties grown in nematode- and fungus-infested soil.

Present methods of controlling the nematode—chiefly crop rotation, fumigation, and the planting of trap or host crops—are not wholly satisfactory. Crop rotation, for example, allows only one sugarbeet crop every 4 to 6 years, a procedure that is generally uneconomical for farmers with small acreages.

Price and his assistants have screened hundreds of thousands of plants in their search for resistance, including commercial varieties, monogerms (single-seeded varieties), plants grown from irradiated seeds, and crosses between sugarbeets and related species that are resistant to the nematode. Lines that show the most promise in preliminary screening then undergo field tests in soils heavily infested with both nematodes and root-rotting fungi.

The fact that the experimental lines yielded significantly more than the commercial varieties indicates resistance to the nematode-fungi complex.

The scientists say some resistance to nematodes is evident, but they are not willing yet to say that the lines are resistant to the fungi. It is pos-

Sugarbeets were grown in 3-gallon crocks—and field plots— in soil infested with both the nematodes and the fungi. These were then compared with sugarbeets grown in noninfested soil.

sible, they think, that the nematode resistance also provides a degree of tolerance for root rot—or that nematode resistance reduces root rot because there are fewer nematode-feeding punctures for the fungi to enter and start infection.

Tests are now underway at Salinas to study the resistance relationship between the nematodes and fungi and to explore the nature of this resistance.☆

A test line of resistant sugarbeets (two at left) produced much larger beets than those of a nonresistant commercial variety (right).

Impact on Sugarbeet Seeds...

Retards germination 15 percent, growth up to 50 percent

■ Impacts that sugarbeet seeds receive during processing can decrease germination and reduce seedling vigor significantly.

The harmful effects of impact have been demonstrated in cooperative research by ARS and the Michigan Agricultural Experiment Station. Scientists duplicated the two most common types of impact occurring in commercial processing—when a stationary seed is hit by processing equipment and when a moving seed strikes another object.

To simulate the first situation, Michigan agricultural engineers O. R. Kunze and C. W. Hall and ARS plant physiologist F. W. Snyder dropped steel spheres through glass tubes onto seeds held in fixed positions. Combinations of spheres of varying weights and tubes of differing lengths were used to produce the desired impact energies. The second condition was duplicated by propelling seeds on a jet of air against a steel plate.

Both kinds of impacts retarded root and shoot development, and impacts of seeds against the steel plate also reduced the percentage of germination.

Greatest damage is to seed cap

Using the steel spheres, the scientists could even determine the varying effects of impacts made on different parts of the seed. Greatest damage occurred in those seeds hit on the seed cap. Depending on the impact energy applied, reductions of growth up to 50 percent were noted.

In the air tests, impact seemed to have a cumulative effect on germination. Although three impacts caused a slight drop in germination, the fourth impact resulted in a marked drop. Germination in seeds hit three times was 93 to 94 percent, whereas germination in seeds hit four times—with the same impact energy—was only 79 to 81 percent.

The tests demonstrated that free fall of seed from any height does not produce sufficient speed and impact energy to cause loss of vigor or decreased germination. Speeds and impact energies reached by the seed in mechanical processing, however, are often sufficient to cause damage to the seed which is not externally visible.

In view of the data gained in these tests, scientists suggest that a new look at processing equipment may be in order. They recommend a greater use of conveyor chutes, a reduction in the number of impact points, and an increased use of slower conveyor belts or of pneumatic systems that employ the minimum air velocity needed to move the seeds.☆

What Cements Cells Together?

Pioneering scientists seek basic answer to how pathogen breaks down cell structure of insects

■ Pioneering scientists of ARS are learning how the insect-destroying pathogen *Bacillus thuringiensis* kills its victim.

This pathogen—already in use against several vegetable insects—is one of numerous microbial agents being studied as biological pest-control weapons (AGR. RES., September 1964, p. 3).

During sporulation, *B. thuringiensis* produces a crystal known to be toxic to at least 100 species of insects, most of them in the order of Lepidoptera (butterflies and moths). In some susceptible insects, the crystal toxin breaks down the cell structure of the midgut.

Scientists at the ARS Insect Pathology Pioneering Research Laboratory, Beltsville, Md., reasoned that some chemical or enzymatic action takes place that destroys the cementing substance that holds the cells together.

But to find out how *B. thuringiensis* acts, they first had to identify the cementing substance.

Laboratory director A. M. Heimpel assigned the problem to biochemists Z. E. Estes and R. M. Faust. Using midgut obtained from the greater wax moth (*Galleria mellonella* L.), Estes and Faust isolated the cementing substance and identified it as hyaluronic acid, one of the main mucopolysaccharides in the animal kingdom.

When the scientists started their identification work, the only known method of obtaining midgut was to dissect insects by hand, too tedious a procedure to obtain the amount of material they needed.

They devised a highly efficient "quick-freeze" method of harvest that not only speeded their work but should be useful to other investigators having need for large amounts of insect gut material. The method: Quick-freeze larvae by placing them on a bed of crushed dry ice, snap off anterior and posterior of frozen larvae, roll the remaining abdominal segments several times between the thumb and index finger to thaw the cuticle and body wall, and apply gentle pressure to extrude the still-frozen midgut.

This harvest method yielded material that was remarkably free of contamination—the larvae were denied food for 2 to 3 hours before freezing, to allow time for emptying of the gut. Since there was practically no contamination, removing fat and protein were the main tasks in isolating the cementing substance.

Biochemists Faust (left) and Estes devised a quick-freeze method of harvesting midgut from larvae, often a necessary step in basic studies of insect pests. To show small size of larva, Faust holds one in tweezers.

Gradually, the other steps were worked out. Briefly, the biochemists—

- Extracted fat with methanol chloroform.
- Removed protein by digesting it with proteolytic enzymes.
- Precipitated the remaining material to get a "clean" carbohydrate.
- Put the precipitate through an ion exchange column to determine the number of carbohydrate components present. They found only one. (In this step the scientists used a technique for separation of mucopolysaccharides that they learned about in a paper by two Swedish scientists, N. R. Ringertz and P. Reichard.)
- Analyzed the carbohydrate chemically to identify the cell-cementing substance as hyaluronic acid.

Now that they have isolated and chemically identified the cell-cementing substance, Estes and Faust are working on the basic problem—how the *B. thuringiensis* crystal toxin breaks down the substance. They are guided by two primary theories:

- The crystal toxin contains the enzyme (hyaluronidase) that breaks down hyaluronic acid, or—
- Hyaluronidase is present in the insect in a chemical structure that keeps it inactive, and it is released when the toxin breaks down part of the chemical structure.☆

Foresters count insects with X-ray

Forest entomologists say it is cheaper and quicker to count bark beetles and wood-boring insects by X-ray than by dissecting bark and wood to locate the insects.

Figures proving this have been released by the Forest Service based on research at the Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.

Dissecting 8- by 10-inch bark samples to locate and count the western pine beetle took 2 hours and 40 minutes per sample at a cost of $5.33. Costs by the X-ray method was $1.23 per sample. Counting wood wasps in wood blocks cost $2.10 per sample by the dissection method, only 66 cents by X-ray.

The Forest Service scientists applied the radiographic method on western pine beetle populations in ponderosa pine. They X-rayed the infested bark samples, then compared the number of insects showing up on X-ray photographs with the number that appeared in the dissected bark. They also measured wood wasp population in blocks of fir wood in this way.

The two methods gave population estimates that were substantially the same for both insects.

Studies of the bark beetle and wood-boring insect populations have been badly handicapped in the past because these insects spend most of their lives inside trees. Dissecting bark and wood to locate the insects, in addition to being difficult and time consuming, destroys some of the insects being studied.

Portable X-ray machines and improved film make the radiographic method useful for studying many kinds of burrowing insects. The principal weakness is its failure to distinguish recently dead insects from live ones. Where this distinction is not important, the overall accuracy and lower cost of the method make it extremely practical.

Research covers shipment of purees

Research in Italy has shown the proper temperature and storage time for peach and apricot puree canned in the United States for shipment overseas.

This research is important to U.S. canners, for whom a lowering of quality during shipment would mean fewer foreign sales.

Scientists at the Experiment Station for the Food-Preserving Industries, Parma, Italy, studied the effects of different temperatures and times of storage on canned peach and apricot purees, under a 3-year grant awarded by ARS.

The scientists found that purees stored at temperatures below 68° F. keep their original taste, smell, color, and nutrients for about 2 years. Purees stored at temperatures above 68° F. lose these characteristics within 6 to 12 months, depending upon the storage temperature—the higher the temperature, the quicker the loss of quality.

U.S. canners and foreign retailers use this information to plan size and frequency of shipments so as to prevent loss of quality.

The grant was financed by foreign currency obtained from the sale of U.S. products abroad under Public Law 480.

Earthworms may spread dwarf bunt

The earthworm may contribute, on a localized basis, to the spread of dwarf bunt, a costly fungus disease of wheat.

ARS scientists investigating the possible role of lower animals in the germination of dwarf bunt spores observed that the earthworm eats spores that have been plowed into the soil and expels them on the surface of the ground, where they can germinate and infect wheat.

Numerous dwarf bunt spores were found in earthworm droppings at a test site near Pullman, Wash., by pathologists J. A. Hoffman and L. H. Purdy, working in cooperation with the three State agricultural experiment stations in Washington, Idaho, and Oregon.

Hoffman and Purdy found no significant difference in the rate or percentage of germination between spores

expelled by earthworms and those recovered directly from the soil. In some smut species, the scientists noted that germination of the spores is retarded when they pass through the digestive system of various animals.

Dwarf bunt spores, unlike common bunt spores, require light and cool temperatures for maximum germination. The scientists are continuing research with other soil organisms in an effort to determine how they may affect germination of dwarf bunt spores—and whether they also spread the disease.

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AGRISEARCH NOTES

Polaris nose fairings . . . of plywood

The Polaris A–3 missile, now in use by the Navy as a weapon launched from submerged submarines, wears a plywood nose fairing designed by the Forest Service in cooperation with the Office of Naval Research.

Several successful launchings have proved its design effectiveness, and the fairing has been adopted as standard for the missile.

Criteria developed for plywood shell structures by engineers at the Forest Products Laboratory, Madison, Wis., were used in designing the missile nose fairing.

Plywood was chosen because it has a low weight for its strength and because it is superior to high-strength metals and plastics in resistance to cracking.

The nose fairing, approximately 6 feet long, is 5 feet in diameter at the large end and 2 feet at the small end.

Pine trees tell of air pollutants

Pine trees that tell when the air is polluted—even what it is polluted with—are being developed by the Forest Service.

This research project began after plant pathologists at the Southeastern Forest Experiment Station, Asheville, N.C., noticed varying types of injury on individual white pines that were exposed to the same pollutant in the same vicinity.

Several hundred seedlings are now being exposed to air pollution in three areas. In each vicinity there is a different major pollutant—fluorine in one vicinity, sulfur dioxide in another, and ozone in another. The seedlings are growing in pots and will be moved from one vicinity to another until each seedling is exposed to all three pollutants.

Previous observations made by the FS pathologists lead them to believe that some seedlings will respond only to a single pollutant and be resistant to others. Such seedings will be valuable as biological indicators of specific toxic substances in the air.

Tests seed for moisture, maturity

One of the methods farmers use to measure moisture of hay crops in the field and thereby determine the stage of maturity has been adapted for use on seed crops by an ARS agricultural engineer.

Working at the Small Seed Harvesting and Processing Laboratory, Corvallis, Oreg., L. M. Klein modified a commercial hay-moisture tester that works on the weight-loss principle.

An operator measures moisture content by packing hay in the tester, weighing, "cooking" on an engine exhaust pipe for 6 minutes, and weighing again. The loss in weight is moisture loss, computed as a percentage of the original weight.

One of Klein's innovations is an insert cartridge to hold the seed samples. The cartridge, which can also be used for hay, is a metal tube with a screen bottom and a screw-on screen top.

Klein also changed the face of the weighing scale. When a predetermined weight of seed or hay is used, the scale now reads directly in percent of moisture loss instead of weight.

The whole device—including Klein's improvements—costs about $30. It is accurate within 2 percent, plus or minus.

Co-ops: Outlets for research

"Cooperatives Help USDA Programs Build America" will be featured in a U.S. Department of Agriculture patio exhibit, October 5 through 23.

As a participant in the Departmentwide exhibit, ARS will display some of many food products developed through utilization research and now manufactured by farmer cooperatives. These include superconcentrated apple juice, redi-wheat, and instant sweetpotatoes.

Also included during the 3-week exhibit will be a film festival, information and publication booths, and panel discussions. Top Government officials and agricultural leaders will be present.

Invitations have gone out to various groups, foreign visitors, young people, and the general public.

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